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The impact of mindfulness meditation on pro-inflammatory biomarkers in patients with end-stage renal disease: A randomized trial

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Abstract

Background and aim: Mindfulness meditation has been inadequately used in patients with end-stage renal disease although it has been effective in reducing pro-inflammatory biomarkers in patients with chronic illnesses. Thus, this study examined mindfulness meditation effect on pro-inflammatory biomarkers and C-reactive protein in patients with end-stage renal disease.

Materials and methods: Repeated measures, randomized, control experimental design was used. A convenience sampling technique was used to select the sample from a hospital located in northern Jordan. The participants were randomly distributed into experimental ($n=31$) and control ($n=31$) groups. During hemodialysis sessions, the group of experiment participants practiced 30 min of the Attentional behavioral cognitive theory version of mindfulness meditation; 3 times a week for 8 weeks). The inflammatory biomarkers including C-reactive protein, tumor necrosis factor-alpha, and interleukin-6 were measured by collecting peripheral blood through venipuncture. These biomarkers were analyzed using the enzyme-linked immunosorbent assay (ELISA) protocol after 5 weeks of the intervention, and at its end (8 weeks). An Excel sheet was used to collect data for participants.

Results: Compared to the control condition, mindfulness meditation led to statistically significant reductions in C-reactive protein and tumor necrosis factor over time but a nonsignificant effect on interleukine-6.

Conclusion: Study's results support the evidence-based practice recommendation of adding mindfulness meditation as a complementary treatment to the nurse's care plans for patients with end-stage renal disease.

Trial registration: Clinical trial.gov; ID: NCT06064708; Date: 09/26/2023.

Keywords

Mindfulness, C-reactive protein, tumor necrosis factor- α, interleukin-6, end-stage renal disease

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Highlights

1. The impact of mindfulness meditation on inflammatory biomarkers in patients with ESRD was examined.
2. Mindfulness meditation significantly reduced CRP and TNF.
3. Mindfulness meditation had a nonsignificant effect on IL-6.
4. The results support integrating mindfulness meditation in the care plans of patients with ESRD.

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Introduction

Hemodialysis is considered an effective and essential therapy to remove harmful waste from the body and to improve the quality of life (QoL) of patients with end-stage renal disease (ESRD). However, patients with ESRD experience multiple stressors,[1] negatively affecting physical and psychological health, especially in relation to the immune system.[2–4] Inflammation is a feature of immunity regulated by the responses to stress.[5] Inflammation is a multifaceted process involving various biomarkers. These biomarkers classified as cytokines are significant regulators of immune function with different roles in the inflammatory processes. Some of them primarily work as pro-inflammatory (i.e., C-reactive protein (CRP), tumor necrosis factor-alpha (TNF-α), and interleukine-6 (IL-6)), whereas others work mainly as anti-inflammatory (i.e., interleukin 10 and interleukin 4).[5–7]

Some of the pro-inflammatory biomarkers are potentially significant for ESRD. High levels of blood pro-inflammatory markers, including CRP, TNF-α, and IL-6, have been found in the majority of patients with ESRD.[8] The etiology of inflammation in patients with ESRD is multidimensional, including patient-related causes, such as ESRD-related symptoms, comorbidity, and hemodialysis-related issues, especially those relating to the biocompatibility and quality of the dialysate and the dialysis membrane. These high levels of pro-inflammatory biomarkers in patients with ESRD have been found to cause injury to other bodily organs in addition to the kidney, increasing morbidity and mortality.[8]

Mind-body connection strategies are purposefully adopted in a wide range of structured interventions and have been proven to be highly effective in treating many physical and psychological symptoms of a wide range of psychiatric conditions associated with diverse chronic illnesses.[9–11] They are made up of a variety of approaches that expand the mind's ability to affect health through emotional strategies. Modalities that connect the mind and body are accessible, simple to use, and can be safe and effective to improve QoL and diverse health outcomes in some clinical populations.[12–14]

Mindfulness meditation, the most popular mind-body connection strategy in literature, has been gaining considerable attention from researchers and healthcare professionals recently.[15] It is characterized as paying attention to and being aware of present experiences in a nonjudgmental way.[11] Various mechanisms underlying the effect of mindfulness meditation on health and inflammatory processes have been proposed. Mindfulness meditation may impact neural regions regulating the pathways of downstream stress responses. It can aid patients to be less reactive to stress and to deal with fluctuating feelings through learning to accept the current experience more effectively and create a state of metacognitive awareness that decreases rumination and stressful automated reactions.[16] Decreasing stress responses is linked to a drop-in sympathetic nervous system activity and a rise in parasympathetic nervous system activity, leading to a significant balance between these two systems. This balance can help lower inflammation by reducing signals from adrenergic sources. Furthermore, boosting parasympathetic activity might also reduce inflammation through the anti-inflammatory cholinergic pathway.[17] Many studies have demonstrated that mindfulness meditation can improve psychophysical symptoms and pro-inflammatory markers (i.e., CRP, IL-6, and TNF α) in different medical populations such as patients with cancer, rheumatoid arthritis, and ulcerative colitis.[10,18,19] Regarding ESRD, few studies have focused on mindfulness meditation's effects on psychological and physical symptoms in patients with ESRD undergoing hemodialysis, but they were hampered by severe limitations, such as small sample sizes and unstandardized intervention protocols. For example, five weekly sessions of mindfulness meditation improved perceived stress and QoL through the development of emotional regulation in patients undergoing hemodialysis.[20] Evidence has also shown that the practice of mindfulness meditation reduced sleep disturbances, anxiety, stress, and depression in such patients.[4,20–24] An extensive literature search did not find any previous study that examined the impact of mindfulness meditation on serum pro-inflammatory biomarkers in patients with ESRD undergoing hemodialysis, although such interventions reduced pro-inflammatory markers (i.e., CRP, interleukin-6, and TNF) in different clinical conditions such as cancer, rheumatoid arthritis, and ulcerative colitis.[18] Thus, the goal of this study is to investigate the effect of mindfulness meditation on pro-inflammatory biomarkers (e.g., CRP, TNF-α, and IL-6) in patients with ESRD undergoing hemodialysis.

Materials and methods

Design

A randomized waitlist, control parallel trial with two groups, and repeated measurement (RM) design were used in this randomized controlled trial. The study was registered by Clinicaltrial.gov (reference number: NCT06064708).

Participants

The study was carried out in a military hospital located the northern Jordan between April 2023 and August 2023. It serves all patients, regardless of whether they have private, military, or public insurance. The hospital includes a dialysis unit with 30 dialysis machine beds and 112 patients are treated on average each week. The inclusion criteria included patients with ESRD who: underwent hemodialysis thrice weekly, were at least 18 years old, were capable of reading and writing in Arabic, and agreed to participate. Patients under total parenteral nutrition, undergoing psychotherapy, taking psychopharmacological or anti-inflammatory drugs, and having immunocompromised and infectious illnesses were excluded from the research.

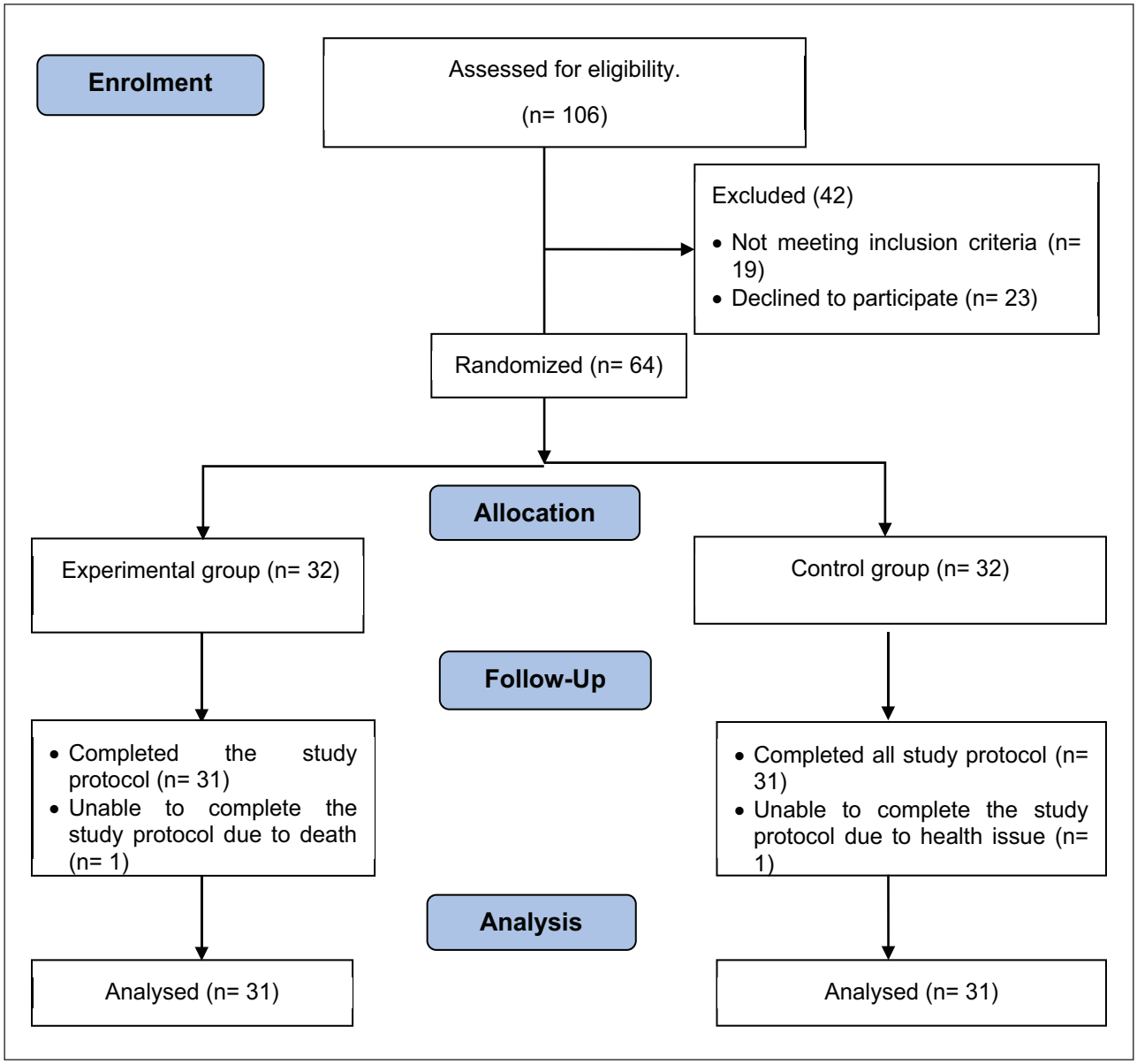

Figure 1. Participant flow diagram.

Using G3.1.1 (ANSI/ASQ Z1.4-2003) model, given a mixed-design repeated measures analysis of variance (ANOVA) (among groups and between groups), effect size of 0.25, Cronbach's alpha coefficient of 0.05, and a power of 0.95, the recommended sample size is 44 patients. Taking into consideration a nonresponse and attrition rate of approximately 45%, as reported in a similar study,[20] the final required sample size was determined to be approximately 64 patients distributed randomly into the experimental ($n=32$) and control ($n=32$) groups. However, of 64 participants recruited, 62 patients only completed the study with 31 in the group of experiment and 31 patients in the group of control (See Figure 1).

Intervention

The experimental group received 30 min of mindfulness meditation according to Smith's[14] mindfulness meditation protocol, which is a standardized theory-based intervention. It was administered during guided chairside interventions during participants' hemodialysis sessions and usually after 30 min of the beginning of the dialysis, 3 times a week over 8 weeks (comprising 720 min in total). This approach has been demonstrated to be viable for ESRD.[20,25]

Smith's[14] mindfulness meditation protocol comprises six components:

1. Being mindful of the breath, by taking deep breaths and simply exhaling with bay attention to airflow (5 min).
2. Focus on your body, scanning from head to toe and observing any physical sensations you experience for 5 min.
3. Focus on your thoughts, observing them as they come and go without holding onto them. Simply notice and release them, then continue to observe your mind for 5 min.
4. Focus on the sounds around you, listening to them without making any judgments. Just notice and release them, remaining open to whatever sounds come next for 5 min.
5. Focus on your walking, imagining a path where you can move freely without concern for the destination.
6. Pay attention to each step's placement for 5 min. Engage in full meditation by opening your eyes and being aware of the present moment. When you notice something—whether a sound, thought, or sensation—let it go and stay open to whatever comes next for 5 minutes.

Participants in the experiment group received records that provide program instructions via WhatsApp and e-mail (iOS and Android), to ensure the consistent delivery of the intervention. It is a free, self-paced program developed by a study researcher (HA) based on Smith's protocol. This study researcher was an experienced practitioner with a PhD degree in nursing and received extensive stress management training, including mindfulness meditation. The audio recording of the mindfulness meditation was evaluated and validated for the clarity of voice and the mindfulness meditation content by two psychologists who are experts in mindfulness meditation. However, a face-to-face foundation course (2 h) was conducted before the actual training sessions by a certified, experienced researcher (IN), who taught the participants in the experimental group the basics of the mindfulness meditation program. To ensure that they could practice effectively after they received appropriate training, they were supervised by a certified practitioner. A checklist was maintained by the practitioner containing all steps of the intervention (each step and the length of time spent on each step) to achieve high levels of adherence. The intervention benefits of the investigation were not determined for participants to prevent bias, and the participants were asked not to use any psychiatric or alternative medicine treatments to enhance sleep or mood, and to notify the researcher of any problems or concerns if needed. In addition, patients' electrical medical records were checked regularly during the intervention to ensure they did not receive any anti-inflammatory or psychological medication, and that they were not suffering from any infectious diseases. Any potential interruption (e.g., the dialysis machine alarm) was managed immediately by the attending healthcare professionals.

The group of control only received usual care, comprising biomedical normative dialysis treatment (the participants in this group did not receive any kind of additional treatment or holistic components). However, upon completion of the study, audio recordings of the intervention protocol were provided and explained to participants in the control group.

Measurements

The data were collected three times (at baseline, after 5 weeks, and at the end of the intervention) using biological blood tests for pro-inflammatory biomarkers and an Arabic self-reported questionnaire that included items asking about the participants'[26] demographic and behavioral characteristics.

Demographic and behavioral characteristics. Age, sex, marital status, smoking status, comorbidities, daily sleep hours, weekly exercise hours, general health, nutritional status, and coping ability were all included in the questionnaire. Three questions were used to evaluate general health status and responses were graded using a five-point Likert scale the group of experiment and group of control.[20]

Pro-inflammatory biomarkers. The inflammatory biomarkers including CRP, TNF-α, and IL-6 were measured by collecting peripheral blood through venipuncture. These biomarkers were analyzed using the ELISA protocol, a laboratory technique used to measure various bio-inflammatory biomarkers, including cytokines, chemokines, and other proteins. It is a powerful tool in the field of immunology and medical research, enabling the detection of specific molecules within biological samples. It is also a valuable tool in research and clinical settings for assessing cytokines, chemokines, and other proteins.[20,27] All the biomarkers measured at the three time points (at baseline, after 5 weeks, and at the end of the intervention) were measured in the same lab using the same conditions.

Procedure

After obtaining the IRB approval from the Jordan University of Science and Technology, the hospital managers were contacted by one of the study researchers who has a master's degree in nursing to get approval for the study. After obtaining approval, the patients were contacted in person to describe the purpose of the study. Patients who decided to participate were asked to sign the consent form. After that, baseline measurements (Time I) were taken in the hemodialysis unit in private contexts, where nobody else was present while participants filled out the questionnaire. A well-trained research assistant

Table 1. Sociodemographic characteristics of experimental ($n = 31$) and control ($n = 31$) groups.

Variable	Category	Experimental group		Control group		X^2/t (p)
		n (%)	Mean (SD)	*n* (%)	Mean (SD)	
Sex	Male	18 (58)		16 (52)		0.26 (0.61)
	Female	13 (42)		15 (48)		
Smoking	Smoker	9 (29)		7 (23)		0.33 (0.56)
	Nonsmoker	22 (71)		24 (77)		
Education	High school	22 (71)		19 (62)		0.71 (0.70)
	Diploma	4 (13)		6 (19)		
	Bachelor	5 (16)		6 (19)		
Employment	Employed	9 (29)	6 (19)			0.79 (0.37)
	Unemployed	22 (71)	25 (81)			
Comorbidity	DM	7 (23)		10 (32)		0.78 (0.67)
	Cardiac diseases	5 (16)		5 (16)		
	Others	19 (61)		16 (52)		
Age			50.74 (15.68)		53.10 (16.13)	−0.58 (0.56)
General health status			2.81 (0.54)		2.94 (0.89)	−0.68 (0.49)
Nutritional status			2.94 (0.72)		2.81 (0.83)	0.64 (0.51)
Coping ability			2.23 (0.76)		2.58 (0.80)	−1.78 (0.08)
Daily sleeping hours			5.65 (2.34)		6.48 (2.69)	−1.30 (0.19)
Weekly exercise hours			1.23 (0.61)		1.32 (0.54)	−0.65 (0.51)

n: frequency; SD: standard deviation; DM: diabetes mellites.

who did not participate in the other study phases collected data, including blood sampling. This research assistant, who was an experienced registered nurse working in the hemodialysis unit for 10 years, followed strict infection control protocol during blood sampling. After that, the participants were randomly distributed into groups according to a straightforward 1:1 computer-generated sequence, giving them an equal chance of being in either of the two groups. The study researcher who was not involved in other phases of the study implemented the randomization. The mindfulness meditation was delivered to the hospital. Participants in both groups had to practice their normal routines of life before the study and not take psychiatric or alternative treatments to improve mood and notify the researcher if necessary.

According to Smith[14] and Ghoncheh and Smith,[28] 5 weeks of actual mind-body training have good outcomes. However, Alhawatmeh et al.[20] found that the practice of mindfulness meditation over 5 weeks was not sufficient to decrease pro-inflammatory biomarkers such as CRP. Thus, they recommended increasing the number of training sessions. Accordingly, in this study, data was collected for the second and third time 5 and 8 weeks after initiating the intervention (Times II and III, respectively) to investigate whether further significant reductions of pro-inflammatory biomarkers occurred between these two measurements. All measurements were privately taken in similar situations and environments in the hemodialysis unit by the research assistant who took the baseline measurements. Nobody was present when participants filled out the questionnaire.

Data analysis

SPSS was used for this study. Repeated-measure ANOVA (RM ANOVA; within-between-subject design) was used to identify the effectiveness of mindfulness meditation over the three points of measurement by condition. To assess whether there were significant mean variances between the study groups at each time measure and between the three time measurements within each group, independent *t*-tests and repeated-measure ANOVA (between-subject only) respectively were conducted as post hoc testing.

Results

Participants' sociodemographic characteristics

The demographic characteristics of groups are displayed in Table 1.

Group comparison on sociodemographic variables

The results of the Chi-square test demonstrated that there were no significant variations between the two groups in terms of sociodemographic and behavioral characteristics (See Table 1).

Table 2. Results of repeated measures ANOVA (within-group) for experimental ($n = 31$) and control ($n = 31$) groups.

Variables	Experimental group ($n = 31$) mean (SD)				Control group ($n = 31$) mean (SD)			
	Time1	Time 2	Time 3	F (p)	Time 1	Time 2	Time 3	F (p)
CRP	1.99 (0.38)	1.86 (0.36)	1.72 (0.41)	7.01 (.002)	1.95 (0.36)	2.01 (0.36)	2.07 (0.31)	1.10 (0.33)
TNF-α	37.68 (1.26)	37.32 (1.17)	36.22 (1.24)	14.78 (0.00)	37.28 (1.48)	37.33 (1.05)	38.96 (1.21)	18.89 (0.00)
IL-6	42.36 (19.72)	53.50 (28.60)	53.02 (16.07)	2.37 (0.10)	42.78 (38.03)	53.02 (42.78)	53.71 (14.10)	1.14 (0.32)

CRP: C-reactive protein; TNF-α: tumor necrosis factor-α; IL-6: interleukin-6.

Descriptive and RM ANOVA (within-subject) results for dependent variables

C-reactive protein. In the group of experiment, RM ANOVA (within-subject only) determined statistically significant main effects of time for CRP ($p < 0.05$) and TNF-α ($p < 0.05$), but statistically nonsignificant time-effect for IL-6 ($p > 0.05$) (See Table 2).

Tumor necrosis factor-α. Table 2 demonstrates a downward trend in the TNF-α mean scores over time for the group of experiments. However, in the group of control, TNF-α means scores increased over time. RM ANOVA (within-subject only) findings determined a statistically significant time-effect for TNF-α in the group of experiment ($F(2, 60) = 14.78$, $p = 0.00$, partial eta squared = 0.33), and in the group of control (F (2, 60) = 0.18, $p = 0.00$, partial eta squared = 0.38).

Pairwise comparisons in the group of experiment indicated significant variances between TNF-α mean scores at Time I and Time III (mean variance = 1.45, $p = 0.00$), and at Time II and Time III (mean variance = 1.10, $p = .001$). However, there was a nonsignificant mean variance between TNF scores at Time I and Time II (mean variance = 0.36, $p = 0.208$).

Interleukin-6. Table 2 demonstrates approximately upward trends in the IL-6 mean scores over time for both groups. RM ANOVA results showed that there was a statically nonsignificant time-effect for IL-6 in the group of experiment (F (2, 60) = 2.37, $p = 0.10$, partial eta squared = 0.07), but contrary to the study hypothesis. In the group of control, there was a statically significant time-effect for IL-6 (F (2, 60) = 1.14, $p = 0.32$, partial eta squared = 0.04).

Pairwise comparisons in the group of experiments indicated significant variances between IL-6 mean scores at Times I and III (mean variance = −10.66, $p = 0.023$). On the other hand, there were statically nonsignificant mean variances between TNF scores at Times I and II (mean variance = −11.14, $p = 0.087$), and Times II and III (mean variance = 0.48, $p = 0.94$).

Analyses of variance on outcomes across three repeated measures by group

C-reactive protein. A 2 × 3 RM ANOVA (mixed model) test was conducted to examine variances in CRP by condition and time. Mauchly's test revealed that the assumption of sphericity was met. The findings showed that there were statistically nonsignificant main effects of time (F (2, 120) = 1.11, $p = 0.33$, partial eta squared = 0.02). However, there were statistically significant main effects of condition F (1, 60) = 4.44, $p = 0.039$, partial eta squared = 0.06) and significant time-by-condition interaction (F (2, 120) = 6.66, $p = 0.002$, partial eta squared = 0.10).

Tumor necrosis factor-α. A 2 × 3 RM ANOVA (mixed model) test was conducted to examine variances in TNF-α by condition and time. The results showed that there was a statistically nonsignificant time-effect (F (2, 120) = 0.81, $p = 0.44$, partial eta squared = 0.10). However, there was statistically significant meaning effect of condition (F (1, 60) = 14.54, $p = 0.00$, partial eta squared = 0.19), and significant time-by-condition interaction (F (2, 120) = 33.31, $p = 0.00$, partial eta squared = 0.36).

Interleukin-6. A 2 × 3 RM ANOVA (mixed model) test was conducted to examine variances in IL-6 by condition and time. The findings demonstrated that the time-effect was significant (F (2, 120) = 3.11, $p = 0.048$, partial eta squared = 0.05). However, there were nonsignificant main effects of condition (F (1, 60) = 0.002, $p = 0.96$, partial eta squared = 0.00) and time-by-condition interaction (F (2, 120) = 0.008, $p = 0.99$, partial eta squared = 0.00).

Post hoc t-tests. At baseline (Time I), t-test results revealed that there were no significant mean variances between groups in terms of CRP (t (60) = 0.41, $p = 0.68$), TNF-α (t (60) = 0.51, $p = 0.25$), and IL-6 (t (60) = −0.05, $p = 0.95$). At Time II, t-test findings determined nonsignificant mean variances between the study groups at Time II in terms of CRP (t (60) = −1.53, $p = 0.13$), TNF-α (t (60) = −0.04, $p = 0.96$), and IL-6 (t (60) = −0.02, $p = 0.95$). At the end of the intervention (Time III), t-test results showed there were significant mean variances between the study groups in terms of CRP (t (60) = −.3.71, $p = 0.00$), TNF-α (t (60) = −8.79, $p = 0.00$), and IL-6 (t (60) = −0.18, $p = 0.85$), See Table 3.

Discussion

In the group of experiment, mindfulness meditation considerably reduced CRP over time, while CRP mean scores dramatically increased over time in the group of control. The

Table 3. Analyses results of variance on dependent variables across three repeated measures by group ($n = 62$).

Variable	F (p)			η_p^2
	Condition	Time	Condition × time	
CRP	4.44 (0.039)	1.11 (0.33)	6.66 (0.002)	0.10
TNF-α	14.54 (0.00)	0.81 (0.44)	33.31 (0.00)	0.36
IL-6	0.002 (0.96)	3.11 (.048)	0.008 (0.99)	0.00

CRP: C-reactive protein; TNF-α: tumor necrosis factor-α; IL-6: interleukin-6; η_p^2: partial eta squared.

post hoc comparison tests in our study revealed that mindfulness meditation significantly improved CRP at Time III, but not Time II. This study was inconsistent with the study carried out by Alhawatmeh et al.[20] who examined the effect of 5-week mindfulness meditation among nursing students and found CRP decreased after 5 weeks, but this did not reach a statistically significant level.

These inconsistent results between the current study and Alhawatmeh et al.[20] may be attributed to the different durations of the interventions used in both studies. In the present study, the effect of mindfulness meditation was examined at Times II and III, and it was only found to be effective after 8 weeks of intervention. However, Alhawatmeh et al.[20] used only a 5-week intervention, which may have been insufficient to make a significant reduction in the CRP. Black and Slavich[18] reported that the evidence of the impact of mindfulness meditation on CRP protein is conflicting. Villalba et al.[29] explained these conflicting results and suggested that mindfulness meditation may reduce inflammation among at-risk populations with elevated baseline levels of systematic inflammation such as patients with chronic or inflammatory diseases.

The outcomes of the current study revealed distinct patterns in TNF-α levels for both the experimental and group of controls. Notably, the group of experiment exhibited a significant decline in TNF-α mean scores over the intervention period. However, the control group exhibited approximately stable mean scores over the study period. Post hoc comparisons between groups displayed significantly lower TNF-α mean scores at Time III, but not at Time II. The reported findings were congruent with earlier research showing how mindfulness meditation impacts TNF-α positively.[29,30] Further investigation into the mechanisms underpinning changes in TNF-α that have been observed in these early studies and examination of how the intervention influences the sustenance of the effects of this crucial inflammatory marker.

The preliminary findings of the study assessing the effects of mindfulness meditation on IL-6 levels in patients undergoing hemodialysis were rather surprising. In stark contrast to the prior hypothesis, the group of experiment exhibited an unexpected upward trend in IL-6 mean scores during the intervention. This paradoxical finding suggests that a reduction in IL-6 levels may not have been achieved by the intervention of mindfulness meditation. The strong time-effect in the group of experiments also suggests that other factors outside the intervention could have been responsible for the IL-6 increments over time.

On the other hand, the group of controls showed a nonsignificant time-effect for IL-6 levels, suggesting that the observed trends were less accentuated in this group. Interestingly, the pairwise comparisons within the group of experiment showed significant variances between the IL-6 mean scores at, Times I and III, suggesting that IL-6 levels showed variability during the intervention period. This result, except for the finding of a prior study, indicated that mindfulness-based stress-reduction intervention significantly increased IL-6 levels in recovering breast cancer survivors. They explained these findings as that B-cell modulation might reflect immune recovery during breast cancer treatment and that increases in IL-6 at the end of the intervention might reflect the MBSRD-related immune restoration process. The surprising results of the present study warrant further research into the complex relationship between mindfulness meditation and IL-6 levels in patients on hemodialysis, possibly involving other variables that might lead to IL-6 fluctuation and responsiveness toward the intervention.

Implications

The study's outcomes suggest that mindfulness meditation can serve as a valuable addition to clinical practice for nurses working with patients having ESRD. These encouraging results present a potential tool for patients undergoing hemodialysis to enhance their physical health. Mindfulness meditation has been found to be an easy, practical, and efficient stress-reduction therapy that counteracts the pro-inflammatory effects of stress. Given the promising results of this study, it suggests nurses offer patient education on mindfulness meditation and in controlling inflammation. Educating patients about mindfulness meditation empowers them to actively participate in their treatment and self-care, improving treatment adherence and patient engagement. The development and integration of mindfulness meditation training as a complementary therapy into hospital policies and care plans for patients undergoing hemodialysis may enhance their physical well-being. Chronic inflammation is a prevalent feature of ESRD and is linked to worse clinical outcomes and elevated cardiovascular risk in these patients. By targeting inflammation through mindfulness meditation, nurses and other healthcare providers have an additional non-pharmacological and cost-effective strategy to improve patient well-being and potentially reduce the risk of complications.

The study showed that the duration of the program of mindfulness could impact the outcomes. Therefore, nurses should consider individualizing treatment plans based on patient needs and preferences. Some patients might benefit

from a shorter, more intensive intervention, while others may require a longer-term approach to experience meaningful improvements. In addition, collaborating with mental health professionals trained in mindfulness meditation can enhance patient outcomes and provide a holistic approach to care.

Conclusion

The findings of this study highlight the potential benefits of mindfulness meditation in managing inflammation in patients undergoing hemodialysis. The results show that the group of experiment significantly surpassed the group of control in terms of TNF-α and CRP. The study results prove that the clinical practice of working with patients who have ESRD may benefit from the addition of mindfulness meditation. By focusing on the present moment and nonjudgmental acceptance, mindfulness meditation gives patients helpful tools to cope with the tribulations of their medical treatment and psychological suffering, which influence the inflammatory process and threaten to increase mortality and morbidity.

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Declaration of conflicting interests

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Ethics statement

The study was by Jordan University of Science and Technology's Institutional Review Board (The approval number: 34/156/2023; Date: 06/04/2023). Participants who agreed to participate in the study were asked to sign a consent form that described the purpose and scope of the research. They confirmed that they had the freedom to reject participation in the study and that such rejection would not affect the care they received. They were assured that the research data would be stored in a secure location in a locked cabinet accessible only to the researcher, with numbers replacing their names to avoid their personal identification. No patients were excluded from the trial because of their gender, race, or nationality. During the intervention, if any patient felt dizzy or uncomfortable, the intervention was stopped, and the attending physician was informed immediately.

Informed consent

Written informed consent was obtained from all subjects before the study.

Trial registration

The study was registered by Clinicaltrial.gov (reference number: NCT06064708).

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Supplemental material

Supplemental material for this article is available online.

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